

**Claims**

- 5 1. Apparatus for monitoring the condition of a storage battery comprising first and second connection conductors each for connection to a respective output terminal of the battery, switching means connected in series with a resistance between the connection conductors and voltage measurement means connected in parallel with the resistance, in which the switching means operates to complete the circuit to allow current to flow between the battery terminals, and voltage measurement means being operative to measure the potential across the resistance during such current flow, the period during which the switching means is closed and the frequency of such closures being such that the power dissipated by the apparatus averaged over several closures being substantially less than the instantaneous power delivered by the battery and in which the current drawn during each closure is of the same order as the short-circuit current of the battery.
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2. Apparatus according to claim 1 in which the switching means includes a solid-state switching device.
- 20 3. Apparatus according to claim 2 in which the gate of the solid-state switching device is controlled by an output of a microcontroller.
4. Apparatus according to any preceding claim in which the solid-state switching device is a MOSFET.
- 25 5. Apparatus according to any one of claims 1 to 3 in which the solid-state switching device is a bipolar transistor.
6. Apparatus according to any preceding claim that comprises an amplifier to amplify the voltage that appears across the resistance.

7. Apparatus according to any preceding claim comprising an analogue-to-digital converter to measure the voltage that appears across the resistance.
- 5 8. Apparatus according to any preceding claim in which the duration of each closure has an order of magnitude of  $10^{-5}$ s.
9. Apparatus according to any preceding claim in which the resistance is of order  $10^{-3}\Omega$ .
- 10 10. Apparatus according to any preceding claim further comprising indicating means operative to indicate the state of a battery to which the apparatus is connected.
11. Apparatus according to claim 10 in which the indicating means comprises indicators that can display lights of one of several alternative colours, the particular colour that is being displayed being indicative of the state of the battery.
- 15 12. Apparatus according to claim 10 or claim 11 in which the indicating means includes a display device that can display one or more alphanumeric characters or one or more icons, the display being representative of the state of the battery.
- 20 13. Apparatus according to any preceding claim further comprising interface means operative to communicate the state of the battery to external apparatus.
14. Apparatus according to claim 13 in which the external apparatus is an electronic control bus of a vehicle.
- 25 15. Apparatus according to any preceding claim including communications means for conveying the state of a battery to a remote location.

16. Apparatus according to claim 15 in which the communication means operates using wireless telecommunication, either as a radio link or cellular telephony.
- 5 17. Apparatus according to any one of claims 1 to 16 further including means for monitoring the output of a charging device for the battery and for issuing a warning in the event of its whole or partial failure.
18. Apparatus according to claim 17 which monitors the characteristic output of the charger over time and issues a warning in the event that this suggests whole or partial failure of the charging means.
- 10 19. Apparatus according to any preceding claim being programmed to enter a sleep mode in which testing is suspended in the event that the battery EMF remains substantially constant for a predetermined period.
20. A lead-acid storage battery comprising apparatus for monitoring the condition of a storage battery according to any preceding claim.
- 15 21. A lead-acid storage battery comprising apparatus for monitoring the condition of a storage battery according to any one of claims 1 to 19.
- 20 22. A storage battery having detection and indicating means integrally assembled on it, comprising: a casing having an upper portion and a lower portion, at least a cell defined within the casing; a cover enclosing the upper portion of the casing; a pair of terminals mounted on the cover, each terminal is electrically connected to the corresponding anode and cathode of the cell; characterised in that, the detection and indicating means includes apparatus for monitoring the condition of a storage battery comprising first and second connection conductors each for connection to a respective output terminal of the battery, switching means connected in series with a resistance between the connection conductors and voltage measurement means connected in parallel with the resistance, in which the switching means operates to complete the circuit to allow current to flow between the battery terminals, and
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- 5 voltage measurement means being operative to measure the potential across the resistance during such current flow, the period during which the switching means is closed and the frequency of such closures being such that the power dissipated by the apparatus averaged over several closures being substantially less than the instantaneous power delivered by the battery and in which the current drawn during each closure is of the same order as the short-circuit current of the battery.
- 10 23. A storage battery according to any one of claims 20 to 22 further characterised in that the electronic circuit further includes a communication means to transmit the processed signal to other display means remotely position from the storage battery.
24. A storage battery according to claim 23 further characterised in that the display means includes a light emitting diode or a liquid crystal display device.
- 15 25. A storage battery according to claim 23, further characterised in that the display means is mounted flush with the cover.
26. A storage battery according to claims 22 or 23 further characterised in that the display means includes a segmented display device for exhibiting a measured value.
- 20 27. A storage battery according to any one of claims 20 to 26 in which the display device is capable of displaying one or more icons to indicate the state of the battery.
- 25 28. A storage battery according to any one of claims 20 to 27 further characterised in that the electronic circuit is assembled and embedded within the cover.
29. A storage battery according to any one of claims 20 to 26 further characterised in that the storage battery for use in a motor vehicle, and the display means is adapted to indicate the condition of the battery

during the engine off and indicate the condition of the charging system of the motor vehicle when the engine is in operation.

- 5           30.       A storage battery according to any one of claims 20 to 29 further characterised in that the electronic circuit is capable of detecting leakage of energy from the battery and indicating the same on the display means while the engine is not running.
31.       A storage battery according to any one of claims 20 to 30 in which the detection and indicating means measures the total potential across all cells of the battery and the internal resistance of the storage battery.
- 10       32.       A storage battery according to any one of claims 20 to 31 including communication means for conveying the state of the battery to apparatus external of the battery.
33.       A storage battery according to claim 32 in which the apparatus external to the battery is a control bus of a vehicle.
- 15       34.       A storage battery according to claim 32 or claim 33 in which the apparatus external to the battery includes communication means for communicating the state of the battery to a remote location.
35.       A storage battery substantially as described herein with reference to the accompanying drawings.
- 20       36.       Apparatus for monitoring the condition of a storage battery substantially as herein described with reference to the accompanying drawings.